

SECTION 1058 -- HIGH TENSILE BOLTS, NUTS, AND WASHERS

1058.01 -- Description

1. All high strength bolts shall meet the requirements in ASTM A 325/A 325M and the modification in this Section.
2. All high strength nuts shall meet the requirements in ASTM A 563/A 563M, or ASTM A 194 and the modifications in this Section.
3. Hardened steel washers shall meet the requirements in ASTM F 436/F 436M and the modifications in this Section.
4. All bolts, nuts, and washers shall be plain (uncoated) unless otherwise specified.
5. Alternate design fasteners or bolting systems not referenced in this specification must be tested and approved by the Department before use.

1058.02 -- Material Characteristics

1. Bolts:
 - a. The minimum tensile strength for bolts with a diameter that is equal to or less than 1 inch (25 mm) shall be 150,000 psi (10300 MPa). Bolts with diameters that are larger than 1 inch (25 mm) shall have a minimum tensile strength equal to 120,000 psi (8200 MPa).
 - b. Type 3 bolts, nuts, and washers must be used to assemble "weathering" steel structures. When structures are painted, then the bolts and the compatible nuts and washers may be Type 1 or Type 3.
2. Nuts:
 - a. If nuts are to be galvanized (hot dip or mechanically galvanized), they shall be heat treated grade 10S or 10S3 (2H, DH, or DH3).
 - b. Plain (uncoated) nuts shall be grades 8S or 8S3 (2, C, D, or C3) with a minimum Rockwell hardness of B89 (Brinell hardness of 180), or heat treated grades 10S or 10S3 (2H, DH, or DH3).
 - c. If nuts are to be galvanized, they shall be tapped oversize the minimum amount required for proper assembly. The amount of overlap in the nut shall be so the nut assembles freely on the bolt in the coated condition and shall meet the mechanical requirements of ASTM Specifications as indicated for nuts in Subsection 1058.01 above.
 - d. Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.

3. Marking:

All bolts, nuts, and washers shall be marked according to the appropriate ASTM Specifications.

1058.03 -- Acceptance Requirements

1. Bolts:
 - a. Proof load tests (ASTM F 606/F 606M, Method 1) are required. The minimum frequency of tests shall be as specified in ASTM A 325/A 325M.

b. Wedge tests on full size bolts (ASTM F 606/F 606M) are required. If bolts are to be galvanized, tests shall be performed after galvanizing. The minimum frequency of testing shall be as specified in ASTM A 325/A 325M.

c. If galvanized bolts are specified, the thickness of the zinc coating shall be checked by taking measurements on the wrench flats or on top of the bolt head.

d. The Contractor may use either English or metric bolts in accordance with Table 1058.01.

Table 1058.01

Metric/English Bolt Substitution Table		
Equivalent * Bolt Sizes		
Metric (millimeters)	English (inches)	Hole Diam. (millimeters)
M6	1/4	7
M8	5/16	9
M10	7/16	12
M12	1/2	14
M14	9/16	16
M16	5/8	18
M20	3/4	22
M22	7/8	24
M24	1	27
M27	1 1/8	30
M30	1 1/4	34
M36	1 1/2	40
M42	1 3/4	46
M48	2	53
M56	2 1/4	62
M64	2 1/2	70
M72	2 3/4	76
M80	3 1/4	86
M90	3 1/2	95
M100	4	107
* All bolts on any structure must be all English or all metric. Mixing is not allowed.		

2. Nuts:

a. Proof load tests (ASTM F 606/F 606M) are required. The minimum frequency of tests shall be as specified in ASTM A 563/A 563M, or ASTM A 194/A 194M. If nuts are to be galvanized, tests shall be performed after galvanizing, overtapping, and lubricating.

b. If galvanized nuts are specified, the thickness of the zinc coating shall be checked by taking measurements on the wrench flats.

3. Washers:

Hardened steel washers shall be tested in accordance with ASTM F 436/F 436M. If galvanized washers are specified, hardness testing shall be performed after galvanizing. (The coating shall be removed before taking hardness measurements.)

4. Assemblies:

a. Rotational capacity tests are required and shall be performed on all plain or galvanized (after galvanizing) bolt, nut, and washer assemblies by the manufacturer or distributor before shipping.

b. (1) Except as modified herein, the rotational capacity test shall be performed according to ASTM A 325/A 325M.

(2) Each combination of bolt production lots, nut lots, and washer lots shall be tested as an assembly.

(3) A rotational capacity lot number shall be assigned to each combination of lots tested.

(4) The minimum frequency of testing shall be 2 assemblies per rotational capacity lot.

(5) The bolt, nut, and washer assembly shall be assembled in a Skidmore-Wilhelm calibrator or an acceptable equivalent device for bolts that are too short to be assembled in the calibrator. See Subsection 1058.03, Paragraph 4.b.(9).

(6) (i) The minimum nut rotation, from a snug-tight condition equal to 10 percent of the minimum bolt tension (minimum bolt tension is equal to 70 percent of the minimum tensile load), shall be:

(a) 240 degrees (2/3 turn) for bolt lengths less than or equal to 4 diameters.

(b) 360 degrees (1 turn) for bolt lengths greater than 4 diameters and less than or equal to 8 diameters.

(c) 480 degrees (1 1/3 turn) for bolt lengths greater than 8 diameters.

(ii) During the tightening process, the Contractor should continuously monitor the fastener tension on the calibration device, the bolt torque indicated on the torque wrench dial, as well as the relative rotation of the nut with respect to the snug-tight position. After snug-tightening the nut to the appropriate tension (shown in the tables below), the nut shall be rotated until the minimum bolt tension (as shown in the appropriate table) has been reached. The bolt torque reading should be recorded as close as possible to the minimum bolt tension. This torque must be less than or equal to the calculated torque obtained from the following formula:

Torque Formula	
$T_m \leq T_c = 0.25 PD$	
Where:	T_c = calculated torque in ft. lbs. T_m = measured torque in ft. lbs. P = measured bolt tension in pounds D = bolt diameter in feet (values shown in tables below)

(7) If the above torque-tension relationship has been satisfied, rotation of the nut should continue (past the rotation point where the minimum bolt tension-torque was taken) in the tightening direction to complete the minimum nut rotation shown in Paragraph 4.b.(6) of this Subsection. The tension reached at this rotation shall be equal to or greater than the turn test tension (equal to 1.15 times the minimum bolt tension). The snug tension, minimum bolt tension, and the turn test tension are shown in Table 1058.02.

Table 1058.02

Table 1000.02									
Bolt Tension Requirements									
SI Standard									
Bolt Diameter (millimeters)	16	20	22	24	27	30	36		
Diameter (meters)	0.016	0.020	0.022	0.024	0.027	0.030	0.036		
10% Snug Tension (kilonewtons)	9	14	18	21	27	33	48		
Minimum Bolt Tension (kilonewtons)	91	142	176	205	267	326	475		
Turn Test Tension (kilonewtons)	105	163	202	236	307	375	546		
US Standard									
Bolt Diameter (in)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Diameter (ft)	0.042	0.052	0.063	0.073	0.083	0.094	0.104	0.115	0.125
10% Snug Tension (kips)	1	2	3	4	5	6	7	9	10
Minimum Bolt Tension (kips)	12	19	28	39	51	56	71	85	103
Turn Test Tension (kips)	12	22	32	45	59	64	82	98	118

(8) If the torque-tension relationship or the rotation-tension relationship as determined in Paragraphs 4.b.(6) and 4.b.(7) of this Subsection does not meet requirements, the fastener assembly lot represented by these test samples shall not be used. However, if allowed by the Engineer, the complete fastener assembly lot represented by these failed test samples may be cleaned, relubricated, and then resubmitted for evaluation.

(9) Bolts that are too short to test in a Skidmore-Whilhelm calibrator may be tested in a steel joint using steel shims with proper hole size and thickness so as to place 3 to 5 exposed threads within the joint. The minimum turn-test tension requirement of Paragraph 4.b.(7) of this Subsection need not apply since there is no way of measuring tension. However, the torque value at proper installation rotation shall be determined as follows: The nut must be snug tightened using the same effort (or torque) required to reach the 10 percent snug tension as shown in the appropriate unit section of Table 1058.02. This "snug-torque" value may be determined by using longer bolts from the same lot that will fit in the calibrator. After match-marking the nut after snug-tightening, the nut shall be rotated to the minimum rotation required for turn-of-nut installation (equal to 1/2 of the rotation values shown in Paragraph 4.b.(6) of this Subsection). The torque value obtained at this installation rotation must not exceed the torque as computed by the formula in Paragraph 4.b.(6) of this Subsection using a value of P equal to the turn test tension shown in the appropriate unit section of Table 1058.02.

5. Reporting:

a. The results of all tests (including zinc coating thickness) required herein and in the appropriate AASHTO or ASTM Specifications shall be recorded on the appropriate document.

b. The location where tests are performed and the date of tests shall be reported on the appropriate document.

6. Witnessing:

The tests need not be witnessed by an inspection agency. However, the manufacturer or distributor that performs the tests shall certify that the results recorded are accurate. Recent calibration documentation (calibrations performed at least on a yearly basis) for testing machines, as well as torque and tension measuring equipment used for performing said tests, shall be provided upon request by the Engineer.

1058.04 -- Documentation

1. Mill Test Report(s) (MTR):

a. MTR shall be furnished for all mill steel used in the manufacture of bolts, nuts, or washers.

b. MTR shall indicate the place where the material was melted and manufactured.

2. Manufacturer Certified Test Report(s) (MCTR):

a. The manufacturer of the bolts, nuts, and washers shall furnish test reports (MCTR) for the item furnished.

b. Each MCTR shall show the relevant information required according to Subsection 1058.03.

c. The manufacturer performing the rotational capacity test shall include on the MCTR:

(1) The lot number of each of the items tested.

(2) The rotational capacity lot number as required in Subsection 1058.03, Paragraph 4.b.(3).

(3) The results of the tests required in Subsection 1058.03, Paragraph 4.b.

(4) The pertinent information required in Subsection 1058.03, Paragraph 5.b.

(5) A statement that the MCTR for the items meets this *Specification* and the appropriate ASTM Specification.

(6) The location where the bolt assembly components were manufactured.

3. Distributor Certified Test Report(s) DCTR:

a. The DCTR shall include MCTR for the various bolt assembly components.

b. The rotational capacity test may be performed by a distributor (in lieu of a manufacturer) and reported on the DCTR.

c. The DCTR shall show the results of the tests required in Subsection 1058.03, Paragraph 4.b.

1058.05 -- Shipping

1. Bolts, nuts, and washers from each rotational capacity lot shall be shipped in the same container. If there is only one production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. The container shall be permanently marked with the rotational capacity lot number such that identification will be possible at any stage before installation.

2. The appropriate MTR, MCTR, or DCTR shall be supplied to the Engineer for acceptance before installation.